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SPACE DEVELOPMENT IN JAPAN

Kankuro Kaneshige

Translation of a paper presented at the Japan Productivity Club, September, 1967, Tokyo

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Time: 19 September 1967 (fall)

Place: Japan Productivity Headquarters

Guest Speaker: Kankuro Kaneshige, Emeritus Professor, Tokyo University

Topic: Space Developments in Japan

The Productivity Club

Introduction by the Master of Ceremonies

Productivity Club
Masanoske Tsuzaki, Vice President

As indicated in your programs, Prof. Kaneshige was going to speak today on the theme "The influence of American space development on the industrial world," but instead of this he will address us on "Space developments in Japan." You will therefore forgive him if references to America slip into his talk at appropriate places.

I do not intend to subject Prof. Kaneshige to a long introduction, but he is the one who founded the National Space Activities Council and served as its chairman. He has a broad background in science and technology and served three terms as chairman of the Council. From this experience he would like to discuss the future of space development in Japan. I myself am completely lost in this field, but looking on as an individual citizen I can see that great sums of money are needed in space development. For this reason a single group or enterprise cannot do it alone. You see articles in the newspapers discussing whether the Japanese economy can assume these great burdens in the future and how it should be done. There is a controversy on splitting the budget into two parts. Laymen are considering what things should be taken as essential, but today we hope to hear from an expert in a simplified form what stage Japanese space development is in, where it is likely to go, and how it relates to that of other countries. Prof. Kaneshige, please. (Applause).

Space Development in Japan

Kankuro Kaneshige,
Emeritus Professor, Tokyo University

As you have just been told, I am Kankuro Kaneshige. I understand that this is the 100th meeting of your society and I am very much honored to speak to you on this occasion. I hope that what I have to say will be appropriate. If you are disappointed at what I say, let me beg your indulgence now.

Space Development

I don't know when we began to use the expression space development in Japan, but it was 16 May 1960 that an advisory body called the Space Activities Council was created by the Prime Minister. There was nothing comparable to this previously as far as I am aware. Mr. Tsuruoka, who recently was appointed our delegate to the UN, was asked, since he was one of the committeemen involved who was then with the Ministry of Foreign Affairs. Even that brief time ago there was hardly any technical vocabulary to describe space development in foreign languages, not even in English.

What is Space?

Space has two meanings in Japanese. One is the traditional space, referred to as universe in English. The other is of more recent origin, the region bounding the earth. This is called space in English. There are words corresponding to this in both French and German, but in Japanese we have decided on the expression universe-space. Therefore space research in English becomes universe-space research in Japanese. Unfortunately I am no authority on the semantics of space terminology in Japanese so let me go on with things I am more familiar with. I do not profess to know the dimensions of space or what its limits are. However, the most distant galaxy that can be detected with present day telescopes is 10 billion light years away. The galaxy of which our sun is a part, the Milky Way, could be traversed in about 100,000 years at the speed of light. Within the Milky Way there are many stars just like the sun, some bigger and some smaller. We estimate that there may be 200 billion. The Milky Way itself is but one of several billion galaxies that fall within the range of the largest telescopes. Even the star closest to our sun is more than 4 light years distant, and if we could travel in a space ship at a speed of 36,000 km/hr (10 km/sec), it would still take us more than 100,000 years to reach it. Astronomical numbers dwarf those that we use in everyday living.

Man of the 20th century has made very great technological strides. He can circle the globe in an hour and a half and even leave the earth's gravitational field. Feats that used to be impossible are now becoming simply difficult. However, if we speak in terms of time and space that we can comprehend, space exploration is still a very difficult goal. For practical purposes it is in the realm of the impossible or only something that we can dream about. Still do any of us feel that these dreams will not someday be fulfilled?

The Definition of Space Research

The planet on which we live has an atmosphere. The atmospheric pressure at sea level is about 1 kg/cm^2 and in an area of 1 m^2 the weight is about 10 tons. Ninety-nine percent of the atmosphere is within 30 km of the earth's surface, and the proportion of the earth's atmosphere above 100 km is less than 1 part per million of the whole. The boundary between the atmosphere and space has not been precisely defined but broadly speaking it is that region beyond 100 km. Since the diameter of the earth is 12,800 km, 100 km is less than 1% of this distance, and if 99% of the atmosphere lies below 30 km, then it is attenuated to 0.5%. Perhaps this is exaggerated but let's take a soccer ball as an analogy. If the ball is 40 cm in diameter and 0.5% of this is 1 mm, then this is barely the thickness of the hide covering it. Today's jets fly at an altitude of 10,000 m (10 km). The SST now under construction will fly at an altitude of 20 km, in other words not more than 0.5 mm from the surface of our 40 cm soccer ball. Although manned spacecraft have orbited at an altitude of 200 km, this is still equivalent to no more than 6 mm from the ball's surface. When Soviet cosmonaut Gagarin flew in the world's first manned spacecraft, newspapers reported that he said

the earth was round. At that time my family imagined that the earth must have looked like the moon, but simple calculations will show that the spacecraft was much too close to earth to give this illusion.

Let me emphasize the importance of this thin layer of atmosphere, however. We must be thankful for it since life as we know it never could have originated on earth. I don't know what space conditions are like, but you know how painfully one can get sunburned at the beach when we stay in the sun too long. It would be very serious if there were no preventative for this. Thus certain kinds of radiation are intercepted and absorbed by the atmosphere. From another viewpoint, however, the atmosphere is a hindrance. Earth-based telescopes and other instruments have limitations because no matter how big we make them or how sensitive they are we must still make observations from beneath a layer of atmosphere. We can compare ourselves with organisms living in the ocean depths where light does not penetrate; their world is a very dark place.

I would like to explain in simple terms the significance of observations made outside the earth's atmosphere. In 1947 the small sounding rocket Aerobee was launched in the United States and measured radiation from the sun and UV from stars and nebulae. On 25 Feb. 1949 a two stage rocket consisting of the German V-2 and the Corporal, developed in the USA, was launched at White Sands, N.M., and reached an altitude of 390 km. In Japan, between 1954 and 1955, Prof. Itokawa, then at Tokyo University, began to develop small rockets, such as the Pencil and the Baby.

Space

On 4 Oct. 1957, 10 years ago, the Soviet Union succeeded in placing into earth orbit Sputnik-7 and in doing this astounded and shocked the world. On 31 Jan. 1958, the United States launched Explorer-1. These shots marked the beginning of the space age. Since Gagarin's space flight on 12 April 1961 the US and Russia have sent up so many manned spacecraft that we can hardly keep track of them. It is no exaggeration to say that countless unmanned spacecraft and probes have been launched, the number being between 1000 and 2000 that have orbited the earth. It would be difficult to present to you now the new knowledge that we have learned from space research; I am not competent to do this nor is this an appropriate occasion.

I do not know of any precise records of how far an unmanned space probe has gone from the earth. I can give you several examples. The Russian Lunik-1, launched toward the moon, missed by a wide margin and went into orbit around the sun as an artificial planet. America's Pioneer-5 set a record by sending back signals from a distance of 37,000,000 km in 1960 and went into an orbit between the sun and Venus with a period of about 311 days. It has been calculated that it attained a maximum distance of 290,000,000 km from the earth in September 1962. It was 26,000,000 km distant in November 1965 and in 1989 it is expected to approach to within 3,000,000 km. American space scientists may have reported on whether radio contact was made in 1965 and 1966 to confirm the actual distances. I have not personally checked on this. Mariner-2, which radioed back valuable information while passing by Venus at a distance of 35,000 km on 14 Dec. 1962, also went into orbit

as an artificial planet. I believe that radio contact was made on 3 Jan. 1963 when it was about 87,000,000 km from earth. All of you will probably recall when Mariner-4 came within 32,000 to 37,000 km of Mars, took photographs, and relayed signals back to earth. This probe also became an artificial planet that orbits the sun. Its signals were tracked until they were lost on 1 Oct. 1965 at a distance of about 300,000,000 km. Even after passing by Mars it continued to send back useful data. The present record for distance is that set by Mariner-4, a distance twice that between the sun and earth. Electric signals, traveling at the speed of light, take about 17 min to span this distance.

The average distance from the earth to the moon is 385,000 km and the region beyond this is commonly referred to as deep space. Of our neighboring planets only Venus and Mars have been targets for space probes. The next most distant planet after Mars is Jupiter. If the solar unit of distance between the sun and the earth is expressed as 1.0, then Venus is 0.72 and Mars 1.52, but Jupiter is a much greater 5.20. After the US fulfills its mission to send a man to the moon, I suspect that the Saturn vehicle could be used to send a space probe to Jupiter, as I saw in a newspaper article apparently reported in Germany. Nevertheless, even at the relatively short distance to Mars radio contact was a serious problem. The most distant planet in the solar system is Pluto, some 6 billion km away. It takes 5 1/2 hr for light and radio waves to reach it. Let's imagine that we are sending a space probe to Pluto. Even traveling at a speed of 10 km/sec it would take 20 years to reach the planet. Actually, then, if we are to define space as the region from which we can receive information transmitted by space probes, it is still premature to refer to the whole of the solar system as space. However, we do have hopes of investigating all of the solar system and should therefore consider it as space. Semantic confusion arises in the Japanese mind since our word space includes this meaning as well as that of the universe.

In this respect there is also some confusion on terms for rockets. You often read in the newspapers about a moon rocket or a Mars rocket, but in reality it is a satellite or other instrumented craft that is launched by a rocket vehicle and in the past few years given names like Ranger, Mariner, or Surveyor. I am no rocket authority but all rockets work on the principle of expelled gases. Although oxygen is essential for jet engines, a rocket engine carries its own oxidizers along and is not dependent on an oxygen-containing atmosphere. In English it is the launch vehicle which has attitude controls and receives signals and puts a space probe or spacecraft into orbit. Mr. Kogawa has often criticized his fellow Japanese for using so many foreign words. Our language, however, has few appropriate terms and it is cumbersome for us to invent our own vocabulary.

Space Development in Japan

As I earlier mentioned, our space rocket development program began at Prof. Itokawa's technological laboratory at Tokyo University in 1954, where I was working at the time. Although doing research on aerodynamics, I remember being told to get data on rocket flight at high speeds rather than construct wind tunnels.

The International Geophysical Year (IGY) was held from July 1957 to December 1958. One part of the program was observation of the upper atmosphere using sounding rockets. In addition, the US and Russia were not only going to use sounding rockets but intended to send up orbiting satellites. The European countries also participated in the rocket program, and the earth was divided into two main regions with three parts of 120° each. Japan assumed responsibility for some of the observations in region 3 since it would have been unfortunate to miss out on these. When Japan formally responded in the IGY program, it came as a surprise to most that we were already experimenting with rockets. Most people thought that the rockets would come from the United States. It was S. Okano who brought in the rocket that was being developed at the Institute of Industrial Sceinces at Tokyo University and who until very recently was the university technology advisor to the Ministry of Education.

Development of a sounding rocket for IGY was speeded up but the work was done under severe budgetary limitations and with considerable difficulty. There was no problem in getting cooperation between thos who wanted to use it for purely scientific purposes and those who were in charge of rocket development. A special committee for rocket observation was established; this was the former space research committee, now included within the Science Council of Japan. A chairman was sought and that is how I became involved in the project of 1956.

Many observations were made during IGY at Michikawa, Akita-ken, but it was not till the end of 1958 that an altitude of 60 km was reached. After this our efforts paid of gradually, and in 1960, five years after we started on rocket development, we reached 200 km, penetrating the E-layer of the ionosphere and reaching the F-layer, much to the delight of the scientists.

On 18 June 1959 Mr. Nakazone was appointed director of the Science and Technology Agency. In order to study plans for promoting space technology he set up a committee with 16 members and on 10 July they held their first meeting. These sixteen included of course Prof. Itokawa, then director of the Tokyo Astronomical Observatory, the head of the Meteorological Agency, director of the Nishizaki Electronics Laboratory, as well as Y. Okano, Council for Aircraft Industries, and Horikoshi, head of the Federation of Economic Organizations. Nakazone himself was included as director of the Science and Technology Agency and I as chairman of the Science Council.

I had recently been invited to go to West Germany and after returning to Japan at the end of the month first heard of these plans. When asked, I first told them to hold off because I was unprepared. Most of you will not remember whether both Nakazone and Prof. Itokawa made the Asahi newspaper but some of you may recall an article about launching an artificial satellite by Japan. I did not intend to cross swords with Nakazone yet I had to express my own opinions. Mr. Nakazone had just been made a Minister and was the youngest cabinet member. I knew he was turning his attention to new fields and had his feet solidly on the ground. We did have a difference of opinion but we have been able to cooperate willingly. Later I learned that I was to be chairman of the National Space Activities Council at the suggestion of Nakazone's agency. The preliminary committee which had advised the director of the Science and Technology Agency was dissolved when the Space Activities Council came into being on 16 May 1960. Before that it had deliberated and

reached some conclusions on plans for developing research urgently needed in space technology. These plans were first communicated to the US and Russia, then to England, France, Canada, Australia, etc., actually this being the first time that they were revealed. Briefly we felt that in the present world situation we would fall seriously behind other countries if we did not establish and organize a program for space development. It would enhance our status and give us the right to speak in the world's councils. The pressing need now in Japan is to establish a national policy for space development and research, inform the people on the basic principles of space research, assure efficient use and cooperation of facilities for research development now being supported, and move toward more progress in research development as has been done with atomic energy. Thus we subscribed to the basic principles of peaceful use and independent public development.

International cooperation through the activities of the scientific organization COSPAR is to be strengthened and accelerated. Our urgent needs are meteorological and sounding rockets that can attain 300-400 km, with a capability of 500-1000 km within several years. The first objective would be to conduct research on critical space phenomena and later develop scientific satellites and a communications satellite. This is still a sound program.

A program for research development would have these goals: 1) to establish as soon as possible a committee on space science and technology (a tentative name) in the Prime Minister's office and a council to take up matters of importance to space science and technology; 2) to promote research development and expand and strengthen training facilities at universities and related national facilities; and 3) to establish appropriate research facilities basic to the development of these plans in the future. Of these first goals a committee on space science was formed immediately and later became the nucleus of the National Space Activities Council. The activities of the first few years, however, were quite different from what had been first envisioned. At the request of the Council, a rocket section was created at the Tokyo University aeronautics laboratory and its name changed to the Institute of Space and Aeronautical Science. It seems to be following along lines as originally conceived, but in fact I don't think that this is the case.

The Space Science and Technology Advisory Committee

Shortly after the National Space Activities Council was formed, the advisory committee visited the United States, Canada, and various European countries for a period of six weeks, in February and March of 1961. I was leader of the group. The first place visited was the JPL laboratory at California Institute of Technology, which was just embarking on a program of deep space studies under contract with NASA. At that time the Ranger program, which is now well known through a series of successes, was just beginning, the Surveyor program was beginning to harden, and we had a briefing on the Mariner. We also heard about the Voyager which is planned for launching in 1971 and will be modified after 1973. It is now the instrument for a Mars shot which has apparently been delayed. Another interplanetary probe, as yet unnamed as far as I know, is being developed with the capability of orbiting Mars and soft landing an instrumented package on the surface of

the planet. It will take more than 10 years to develop the Voyager spacecraft and actually send it on this mission. At NASA headquarters in Washington I got firsthand briefings on Tiros and Nimbus, both weather satellites, and Echo and Relay, communications satellites. Private industry is moving ahead with the development of a communications satellite which has aroused considerable interest. For example, there is Telstar, proposed by AT&T, a comsat in polar orbit at mid-altitude with capability of 24 hr relay throughout the world. In addition General Electric proposes a system of 10 satellites in equatorial orbit at mid-altitude to relay signals to the main countries of the world. There are also stationary satellites like NASA's Syncom and Comsat's Earlybird. At the present time communications satellites pose few problems, but at that time it was not known just when a satellite would be launched into synchronous orbit. There were questions of reliability and endurance. A stationary satellite must be placed in an orbit 36,000 km high and it takes more than 0.2 sec to transmit signals. I remember that some were afraid that such a signal delay would be an obstacle to telephone communication.

During my visit I was asked the same question by everybody: Why was Japan embarking on an expensive space program? My answer was the same each time; namely, we are not doing it on the scale of the US and Russia and space development must be pursued by any and all countries in the world. It's the same as an orchestra. It doesn't matter what kind of instruments you have, it matters more how well you play them and how much of a contribution you can make. Once when I said that we were not considering the launching of any artificial satellites ourselves, one scientist said that I must really mean that we wouldn't try it at this time!

Report of the National Space Activities Council

A report on basic plans for promoting space development incorporated the results of the observations and study I have just mentioned and was presented to the Prime Minister on 11 May 1962. Two years had passed since the first advisory committee had presented its conclusions and developments made in the interim were included. Although the plans were extremely detailed, things had not really changed that much. However, a report on important objectives in space development and plans for achieving these was issued, to be put into effect 30 Jan. 1963. The Council reported on these 3 Feb. 1964, stating that a satellite should be launched in the near future using our own resources and that a centralized agency should be set up in order to make maximum utilization of technological, financial, and other resources. The advisory committee was to be continued and reports made on the items previously mentioned in this talk. Of these, three were raised: 1) the construction of a satellite in Japan but launching to be accomplished with a booster rocket from a foreign nation so as to speed up the work; 3) fostering rocket capability and development of long range plans for these; 5) development of research with sounding rockets.

An Agency for Effecting the Plans

For quite a long time I felt a concern for this kind of advisory

committee, but the Prime Minister, who receives this kind of report, passed it along as was without any special suggestions to the administrative agencies concerned. The matters taken up by the National Space Activities Council lie not only within the province of the Science and Technology Agency, they also involve national universities. The committee came under the jurisdiction of the Prime Minister's office and the report was made out for the cabinet and the Prime Minister. Since the Prime Minister can't be expected to make decisions on every minor item, I think we need some means of taking action within the administration, but I haven't heard that this was actually being considered. Therefore, after the report is passed along by the Prime Minister and reviewed, we can start implementing anything in the report that we want to. Certainly it is held in high regard, but if there is something there that we don't want to try to do, there is nothing to make us do it. For example, the first item, satellite development, while surely very important, does not really have such urgency. We are expected to develop and produce satellites, although we have not come very close to this. By contrast, we have been encouraged by our program to foster rocket capability. This program has attracted considerable attention and I get the impression that we are making real progress.

After I returned from abroad in 1961, I was faced with the question of whether to enter into a five year program with radio astronomers for developing a scientific satellite and make observations in cooperation with NASA. It would have cost about $5,500,000 a year or almost $30,000,000 in five years. I recently heard that the British and Canadians, although moving ahead with the plan and not encountering any great delays, are not now planning to carry it through. Some disagreed with our decision at the time, and now that we have just about finished our first satellite, it is too late to go and ask NASA again. Our only alternative is to achieve a launch with a Japanese rocket as quickly as possible and I fervently hope that this will be done soon. Last fall we tried three times to launch the L4S at the Tokyo University space and aeronautics laboratory. We did not succeed and have been severely criticized for these failures. However, the Tokyo University group did not say that they would launch a satellite; they said there was a possibility of doing so. The press reports do not seem to agree on this point, but if you believe the newspapers, Tokyo University is not telling the whole truth. I am not the judge of who is telling the truth or not. Going back to the story told by Tokyo University, they claim that the launch was to be made with the simplest attitude control system yet devised. Those who later criticised them wondered just how did we ever expect to achieve an orbit with that kind of system. If you side with the university, they did not admit to trying to develop and launch a satellite, even if only a scientific satellite, at least not before the National Space Activities Council report was made public. In any event they probably would have been accused of developing an ICBM if the control system were of a highly sophisticated degree of technology. For all we know it may have been the simplest attitude control system in the world, but actually we cannot claim that it had not previously been devised by anyone. A system similar to ours had earlier been developed by a private space concern in the United States. The requirements for putting even the simplest satellite into orbit pose tremendous difficulties. The Scout rocket control mechanism is apparently the simplest successful one. First

used about 1960, Scout is a 4-stage solid fuel rocket, still in use to launch scientific satellites. Either orbicular or elliptical orbits can be achieved and the reliability has been very high from the beginning. No matter what the orbit, the velocity of a satellite must exceed a certain minimum value and it must be placed close to the proper angle to the horizon. As an example let me explain the IBM display at the Seattle World's Fair which opened in 1962 and which some of you may have visited. IBM had an electronic computer to which visitors could address three numbers. The computer calculated at once when orbit was reached and your number became a satellite. A print-out of the shape of the orbit was handed over to you and the machine said congratulations. I had a low elliptical orbit at a velocity of 8 km/sec. Rocket fuel was expended at an altitude of 253 mi with a final velocity of 23,000 mph and an angle of +1.85°. The final orbit print-out gave an apogee of 33,604 mi, perigee 248 mi, and a period of 1,022 min.

A synchronous orbit is attained at an altitude of 35,790 km with a perfectly orbicular path. Not only must rocket speed and precise attitude control be exact, it is essential to have instruments which receive radioed commands to control jets for movement. Whether or not transmitting stations will be ready in time in Japan is a question. It is necessary to employ the same technology that one would use in sending a scientific satellite to the moon. As I mentioned earlier the Russians launched the first satellite ten years ago. I really doubt that after this long a time that a launching enhances national pride. Other Japanese obviously feel the same way. Even a friend of mine at an American university -- a Japanese naturally -- said that we would of course be delighted to launch a satellite with a Japanese flag but having done this we must consider what comes after this. Nevertheless, technicians working on the development of a rocket in Japan are enthusiastic, those working on satellite applications seem to be more on the defensive from what I have seen. I don't think we have placed enough emphasis on satellite development and technology. Perhaps I am mistaken in thinking that the British and Canadians are not worried by the delays in developing their own observation satellites.

Improvement of the Level of Technology and Space Development

The benefits accruing from expenditures in developing space technology are many, especially as they improve the level of industrial technology. For example, the Orbiting Solar Observatory-1 was launched 7 March 1962 to make observations on the sun. After achieving a circular orbit at an altitude of 580 km, the receivers were turned toward the sun. The degree of accuracy was equivalent to aiming at and hitting a one cent coin at a range of a half mile. It is obvious that a number of technological problems had to be solved in order to attain this level of accuracy. The same holds true for a comsat. The technology for making synchronous satellites is very high, and we can expect more progress in the development of communications satellites. It is worth trying for us because of Japan's emminent position in electronics. Certainly it is one area in space science where Japan can contribute much. When I say worth trying, I do not mean that Japan will go it alone in setting up a world-wide comsat network. We should remember that space communication

is a relatively old concept. While my information may not be perfect, it was in 1946 that a conversation took place between Washington and Hawaii using the moon's surface as a reflector. I know that plans for such a development were also being made at NASA when the agency was created in 1958. In addition it is significant that private industry in the United States was conducting research quite early. I don't know how actively it was pursued at first or whether NASA provided funds. I suspect they did.

Photographs of Mars taken by Mariner-4, which I mentioned earlier, were assembled from individual numerical values radioed to earth. It took more than eight hours to transmit one photograph. Now, if you think ahead to future interplanetary probes, you can realize how far our technology must still go, for the eight hours needed to transmit a photograph with the Mariner must be reduced to a matter of seconds. It is predicted that this goal can be reached in five years. Many new kinds of technology result as spinoff from this kind of development, and these are not limited to the field of general communications. Cumulative circuits so actively discussed of late probably first came about through the needs of the military, but they are generally acknowledged as a real contribution to the progress of the American space program. We are lucky of course not to have to support a large military establishment, but we must take up problems which are in great need of investigation and then move into areas where the technological development is incomplete. The Americans started ten years ago and were looking ahead five years. We must now start with a long range program.

Finally I would like to digress on the US Apollo program briefly. If it succeeds, astronauts will return with rock samples from the moon's surface. These will be measured and analysed so as to gain firsthand knowledge of the moon. Proposals on how this should be accomplished were sought from scientists all over the world. The deadline for these proposals was 15 June last year but I received a cable only on 12 May. NASA also requested proposals on applications for astronomical observations by satellite, for example solar or geophysical observations, but up to now not a single Japanese applicant was accepted. One exception was a proposal by Prof. Tanaka at Nagoya University on cosmic ray electrons, a proposal which also originated with a Dutch scientist at Delft Technological University. The satellite, OGO-E, is to be launched next year and the NASA people knew about Prof. Tanaka's proposal yet they officially decided to collaborate with the Dutch scientist at Delft. Under these circumstances I have serious doubts that there will be many successful applicants from Japan, even if moon samples are obtained. Fortunately there was a proposal from Prof. Hisano at Tokyo University, an evaluation of which was published in March of this year. Three items in his proposal were adopted. These were summarized rather fully in the Asahi newspaper at that time and perhaps some of you remember them. We are not just an isolated group conducting space research, we are part of an international effort. As you can imagine, the samples brought back from the moon will be very small. Obviously NASA will not be able to distribute samples to every scientist in the world who would like to analyse them. That Japan should get recognition for three items is a real achievement in this field!

As the astronauts return from the moon they will be quarantined and the samples turned over and classified. It will be essential to do this with

extreme care so as to avoid contamination with terrestrial organisms, gases, and other substances. NASA is constructing a special facility at Houston, the LRL (Lunar Receiving Laboratory) in order to accomplish this. Since this is almost completed, we were invited to attend an opening conference there 18-20 September. Naturally we were to provide our own travel expenses, but none of the governmental agencies were prepared to pay them. Luckily a Japanese scientist was on his way to Columbia University in New York and we asked him to attend the conference by stopping off at Houston en route. He needed about $280 to be able to go there and I was asked to find this sum. I finally went to the Toyo Foundation (Society for Promoting Rayon Technology) which was able to give us this paltry sum. The conference started yesterday in Houston and I hope our man is there.

In closing I ask your indulgence if I have talked too much about myself. I am but one player in the orchestra that makes up the whole Japanese effort. I have already gone over my time and will stop here. (Applause).

Discussion

Tsuzaki: Frankly I was concerned about your topic and when you consented to come I had planned a talk of about one hour followed by a question period. We are right on schedule. Now that we have heard an account of the status of our space program, let us have some questions from the audience.

Question: How much progress has Red China made?

Kaneshige: I don't have any idea. They are certainly aiming for an ICBM and this is a very difficult goal. It will not be easy but just remember how fast they developed nuclear weapons. Perhaps they can duplicate this success with an ICBM.

Question: You have worked both in the Science and Technology Agency and in the academic world. We are always hearing about coordination or unification of our programs. How would this affect our rocket program? Would unification be an improvement?

Kaneshige: A question like this is very difficult to answer, but I think that an excessive amount of technological research at universities is not desirable. If something can be better developed in another laboratory, then it should be done there, if it is to be done well. Speaking from the present funding aspects, the actual amount of money is relatively small and I don't think the taxpayer's money is being wasted. At the same time I would not say that the two main groups working in space development have cooperated very much, at least until very recently. This is truly a waste. There should be cooperation, but there are many ways to interpret "unification" and many ways to achieve it. Yet I question whether this should be done in one place. We would not have this problem if there had been mutual consultation in the past as well as specific responsibilities. However, just because other countries have unified programs does not mean that this would be the best course in Japan. When done in other areas it has sometimes proved to be a wasteful step.

The Science and Technology Agency is in charge of a weather satellite, and a report on this is actually being written now. In March we conducted

joint experiments with NASA at Wallopps Island. We sent ten rockets and they had ten. These were launched simultaneously to get comparative data on temperature, etc. This was accomplished in cooperation with the Meteorological Agency, the Science and Technology Agency acting as the intermediary. The rocket used in these tests was the MT135 developed at Tokyo University. The people in charge of the Science and Technology Agency are highly qualified and there is really no problem in that they did not develop the rocket. They instigated the cooperative effort. I would like to see everything go this way. Last year the groups concerned with satellite tracking had mutual consultations, and the Science and Technology Agency assumed responsibility for this phase, with the cooperation of the Ministry of Posts and Telecommunications as well as the assistance of Tokyo University in experimental work. The Science and Technology Agency will take over tracking of satellites that Tokyo University is planning to launch. This year's budget for the Science Agency has been increased. The funds are needed for this work and there is no duplication. This is an example of how we should move ahead with our space program.

Question: I realize that there has been much talk about unification, but I wonder if it is absolutely essential or not. When a project takes a large amount of money, there must be some unification, for otherwise there would be a scattering of efforts and greater cost. However, each worker will do his best if there is flexibility. Perhaps the National Space Activities Council could give some direction, or some other committee help out.

Kaneshige: I recently read about a similar idea; it seems very reasonable to an outsider and also understandable. But an advisory committee has its limits. If the people who make it up do not take an active interest in it, not much is going to happen. The space advisory committee was terminated in June, but no new members have been appointed and nothing is being done. If the council doesn't have the incentive to meet and confer, our expectations cannot be very high.

Question: If so, the National Space Activities Council being an advisory council, is it not the Science and Technology Agency that determines the broad direction?

Kaneshige: Not that agency alone. Universities are making some contribution and they must be taken into consideration. We have avoided telling the universities what they should do. I personally believe we should give them a certain amount of direction, but we can't do this entirely in a unilateral fashion. Those in universities must carefully weigh how any limitations should be construed. There are many people outside of the universities who are convinced that the Science and Technology Agency should have an overall view of the program, at least those not connected with universities.

Question: Don't you feel, though, that there should be an agency which clearly has authority to decide these matters?

Kaneshige: I first worked on that, and when later considering how it would best be done, we thought it proper to combine the present two groups into one. A finalized plan for effecting this, however, is very difficult to arrive at. I was appointed to a special committee of the Liberal Democratic Party recently established. At that time I said that I didn't know what form of organization would be best, but in any event that was the first thing to decide. The Atomic Energy Commission is now trying to set up a very similar

committee. However, I don't know who is going to put in the hard work to organize it. The newspapers emphasized the budgetary demands of the Science and Technology Agency, some hundreds of millions of dollars, but failed to note the importance of creating this committee. If we organize a committee that is left behind, it will be difficult to gain a picture of the whole, although expenses will increase. At such a time they might tell me to do something about the problem because I had previously been connected with it, but I am simply not aggressive enough to do it.

Question: Aren't there many beneficial by-products in a large scale space program? For instance, there is teflon, now found in every household. Would you tell us about several of these products that have practical applications?

Kaneshige: There are a number of such products, but not having had much to do with them I really can't answer your question. Perhaps the most significant by-product is communications. Communications satellites are cheaper than underseas cables. Next year a comsat will be put in synchronous orbit over the Indian Ocean, making three of these. Channels are becoming clogged. The satellite over the Pacific Ocean is very busy and a second one is supposed to be launched.

Question: I remember seeing an article in the newspapers to the effect that a satellite would be launched in a synchronous orbit about 1973. Does Japan really have this capability?

Kaneshige: I don't know but if the Science and Technology Agency is going on this assumption, I have considerable doubt as to what plan will be used, how many scientists will be needed, and how much money it will take to complete the job. I can't say that it won't be done.

Question: I am a rank amateur in these matters and I may be asking a stupid question, but as far as space development is concerned, what is our rank in the world as you see it? Will we become a strong space nation and how would we compare with Russia, the United States, or Canada?

Kaneshige: It is also difficult to answer this question. We have an international committee called COSPAR which I mentioned earlier. This committee has nothing to do with rocket development but deals only with scientific observations. There are 35 countries that have ties with this committee, but when first formed it was nowhere near that big. In the beginning any country which had launched a satellite contributed $10,000 each year, these including Russia and the United States. Countries which had launched sounding rockets paid $5,000. Japan was one of the original members along with England, France, and later Canada. It is still growing.

As you are well aware, the United States, Russia, and France have launched satellites. There are still two other international organizations in Europe different from COSPAR. One is ELDO (European Launcher Development Organization) for satellite launching. This group had its origin when England was developing a rather large rocket, the Blue Streak, in which they had invested close to $300,000,000. They finally decided to purchase military rockets from the US and used the Blue Streak for a cooperative scientific program with other European countries. The Blue Streak is the booster, the second stage is being made by France, the third stage by Germany, and the satellite by Italy. The whole program will take several years. The initial outlay is about $200,000,000 with 10 countries participating. So far it has

not been completed and promises to cost much more than this.

The second organization is ESRO (European Space Research Organization). It is planning scientific satellites and coordinating projects. At first it cooperated with NASA.

Now, how can we assess Japan's rank in space achievement? The question of a satellite had not previously been discussed much in Japan. If we had asked the United States for help in a launching, it would be said that we lack advanced technology but given time and money we would be better off launching our own satellite. When Americans see this argument, they say obviously we have less developed technology but it is unreal to speak of anyone being ahead since countries with satellites have built up a satellite technology. The Japanese can hardly assess their satellite technology and this has not come up. Since you have only brought up the question of booster rockets or launching technology, look at it this way. If one country asks another for help in a launch, it is the requested country that has the advanced technology. There is a highly significant technological value implicit in rocket launchings, but it is unjust to say that scientific satellites have less significance. For example, the Italians have set up and are now executing an interesting program called the San Marco Plan. A satellite was launched from a sea-based platform at the equator at an angle of 0°. The launching was successfully made last spring with an American Scout booster. Extremely interesting observations resulted because of the equatorial orbit, but I don't know any details about them. The workmanship was outstanding, yet there was hardly a single word about it in the Japanese newspapers. The Italians were not judged merely on whether the booster rocket was made in Italy or not. On the other hand, France's satellite launching was widely acclaimed in the press here. Everybody knows that we are trying to launch a satellite with a rocket developed at Tokyo University.

Since 1960 there has been at least one symposium in Japan in which many foreign scientists have participated. More than half of the papers presented deal with rockets and industrial technology. In this respect countries like the United States have little to learn here. When results on work with scientific satellites are presented, they like to come to hear them, but on the whole not many scientists are coming. Papers in satellite technology are often published by Japanese but not many of these appear in the symposium. The symposium is called "Space Technology and Space Science Symposium." A number of countries have "space science and technology," but the fact that only the Japanese convene a symposium with the theme "space technology and science" is perhaps indicative that people who are technologically oriented are extremely positive. There have recently been many enthusiastic scientists oriented to pure science but they can't possibly exceed the number in technology. In conclusion, although it is difficult to say what point we are at and make comparisons, we can be counted among the countries with space programs. I don't know if we are third or fourth. After all, you can't say that the differences between the first and second position are very great.

Tsuzaki: I think that is all of the questions and it is time to adjourn. Thank you very much. (Applause).